

THE CLAIMS

I claim:

5 1. A layered catalyst composite comprising a first layer and a second layer:

(a) the first layer comprising a first support and a first platinum component;

and

(b) the second layer comprising a second support and a SO_x sorbent
10 component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

2. The layered catalyst composite as recited in claim 1, wherein the first and second supports are the same or different and are compounds selected from
15 the group consisting of silica, alumina, and titania compounds.

3. The layered catalyst composite as recited in claim 1, wherein the first and second supports are the same or different and are activated compounds selected from the group consisting of alumina, silica, silica-alumina, aluminosilicates, alumina-zirconia, alumina-chromia, alumina-titania, titania -zirconia,
20 ceria-zirconia, lanthana-zirconia, and alumina-ceria.

4. The layered catalyst composite as recited in claim 3, wherein the first and second supports are activated alumina.

25

5. The layered catalyst composite as recited in claim 1, wherein the SO_x sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at 350°C.

6. The layered catalyst composite as recited in claim 5, wherein the SO_x sorbent component has a free energy of formation from about -30 to about -55 Kcal/mole at 350°C.

5 7. The layered catalyst composite as recited in claim 1, wherein the SO_x sorbent component is selected from the group consisting of oxides and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, copper, zinc, and silver.

10 8. The layered catalyst composite as recited in claim 7, wherein the SO_x sorbent component is selected from the group consisting of MgO , MgAl_2O_4 , MnO , MnO_2 , and Li_2O .

15 9. The layered catalyst composite as recited in claim 8, wherein the SO_x sorbent component is MgO or Li_2O .

20 10. The layered catalyst composite as recited in claim 1, wherein the first layer further comprises a first platinum group metal component other than platinum.

25 11. The layered catalyst composite as recited in claim 10, wherein the first platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

30 12. The layered catalyst composite as recited in claim 11, wherein the first platinum group metal component is palladium.

 13. The layered catalyst composite as recited in claim 1, wherein the second layer further comprises a second platinum group metal component.

14. The layered catalyst composite as recited in claim 13, wherein the second platinum group metal component is selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium, and mixtures thereof.

5 15. The layered catalyst composite as recited in claim 14, wherein the second platinum group metal component is platinum.

10 16. The layered catalyst composite as recited in claim 13, wherein the second layer further comprises a second platinum group metal component other than platinum.

15 17. The layered catalyst composite as recited in claim 16, wherein the second platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

18. The layered catalyst composite as recited in claim 1, wherein the first layer comprises at least about 1g/ft^3 of the first platinum component.

20 19. The layered catalyst composite as recited in claim 13, wherein the second layer comprises at least about 1g/ft^3 of the second platinum group component.

25 20. The layered catalyst composite as recited in claim 1, wherein the second layer comprises from about 0.03g/in^3 to about 2.4g/in^3 of the SO_x sorbent component.

21. The layered catalyst composite as recited in claim 20, wherein the second layer comprises from about 0.3g/in^3 to about 1.8g/in^3 of the SO_x sorbent component.

22. The layered catalyst composite as recited in claim 1, wherein the first layer further comprises a NO_x sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components.

5

23. The layered catalyst composite as recited in claim 22, wherein the NO_x sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium, oxides of potassium, sodium, lithium, and cesium, and oxides of cerium, lanthanum, praseodymium, and neodymium.

10

24. The layered catalyst composite as recited in claim 23, wherein the NO_x sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium.

15

25. The layered catalyst composite as recited in claim 23, wherein the NO_x sorbent component is selected from the group consisting of oxides of potassium, sodium, lithium, and cesium.

20

26. The layered catalyst composite as recited in claim 23, wherein the NO_x sorbent component is selected from the group consisting of oxides of cerium, lanthanum, praseodymium, and neodymium.

25

27. The layered catalyst composite as recited in claim 22, wherein the NO_x sorbent component is at least one alkaline earth metal component and at least one rare earth metal component selected from the group consisting of lanthanum and neodymium.

30

28. The layered catalyst composite as recited in claim 1, wherein at least one of the first or second layers further comprises a zirconium component.

29. The layered catalyst composite as recited in claim 1, comprising:

(a) in the first layer;

(i) from about 0.15g/in³ to about 2.7g/in³ of the first support;

(ii) at least about 1g/ft³ of the first platinum component;

(iii) at least about 1g/ft³ of a first platinum group metal component

5 other than platinum;

(iv) from about 0.025g/in³ to about 0.7g/in³ of a NO_x sorbent component selected from the group consisting of alkaline earth metal oxides, alkali metal oxides, and rare earth metal oxides; and

10 (v) from about 0.025g/in³ to about 0.7g/in³ of a first zirconium component; and

(b) in the second layer;

(i) from about 0.15g/in³ to about 2.7g/in³ of the second support;

(ii) from about 0.3g/in³ to about 1.8g/in³ of the SO_x sorbent component;

15 (iii) at least about 1g/ft³ of a second platinum group component;

(iv) at least about 1g/ft³ of a second platinum group metal component other than platinum; and

(v) from about 0.025g/in³ to about 0.7g/in³ of a second zirconium component.

20

30. The layered catalyst composite as recited in claim 29, wherein at least one of the first or second layers comprises from about 0.025g/in³ to about 0.5g/in³ of at least one rare earth metal component selected from the group consisting of lanthanum metal components and neodymium metal components.

25

31. The layered catalyst composite as recited in claim 1, wherein the composite is in the form of a pellet with the first layer on the inside and the second layer on the outside of the pellet.

32. The layered catalyst composite as recited in claim 1, wherein the first layer is supported on a substrate and the second layer is supported on the first layer opposite the substrate.

5 33. The layered catalyst composite as recited in claim 32, wherein the substrate comprises a honeycomb carrier.

34. An axial layered catalyst composite comprising an upstream section and a downstream section:

10 (1) the downstream section comprising:

 (a) a downstream substrate; and

 (b) a first layer on the downstream substrate, the first layer comprising a first support and a first platinum component;

 (2) the upstream section comprising:

15 (a) an upstream substrate; and

 (b) a second layer on the upstream substrate, the second layer comprising a second support and a SO_x sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

20 35. The axial layered catalyst composite as recited in claim 34, wherein the upstream section and downstream section are the upstream section and downstream sections of a single substrate.

 36. The axial layered catalyst composite as recited in claim 35,
25 wherein the single substrate is a honeycomb substrate.

 37. The axial layered catalyst composite as recited in claim 34, wherein the upstream section comprises an upstream substrate and the downstream section comprises a downstream substrate, separate from the upstream substrate.

38. The axial layered catalyst composite as recited in claim 37, wherein the upstream substrate and downstream substrate are honeycomb substrates.

39. The axial layered catalyst composite as recited in claim 34,
5 wherein the SO_x sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at 350°C .

40. The axial layered catalyst composite as recited in claim 34,
wherein the SO_x sorbent component is selected from the group consisting of oxides
10 and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, copper, zinc, and silver.

41. The axial layered catalyst composite as recited in claim 40,
wherein the SO_x sorbent component is selected from the group consisting of MgO ,
15 MgAl_2O_4 , MnO , MnO_2 , and Li_2O .

42. The axial layered catalyst composite as recited in claim 41,
wherein the SO_x sorbent component is MgO or Li_2O .

43. The axial layered catalyst composite as recited in claim 34,
20 wherein the first layer further comprises a first platinum group metal component other than platinum.

44. The axial layered catalyst composite as recited in claim 34,
25 wherein the second layer further comprises a second platinum group metal component.

45. The axial layered catalyst composite as recited in claim 44,
wherein the second layer further comprises a second platinum group metal
30 component other than platinum.

46. The axial layered catalyst composite as recited in claim 34, wherein the first layer further comprises a NO_x sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components.

5

47. The axial layered catalyst composite as recited in claim 34, wherein at least one of the first or second layers further comprises a zirconium component.

10

48. The axial layered catalyst composite as recited in claim 34, comprising:

(a) in the first layer;

(i) from about 0.15g/in^3 to about 2.0g/in^3 of the first support;

(ii) at least about 1g/ft^3 of the first platinum component;

15

(iii) at least about 1g/ft^3 of a first platinum group metal component other than platinum;

(iv) from about 0.025g/in^3 to about 0.5g/in^3 of a NO_x sorbent component selected from the group consisting of alkaline earth metal oxides, alkali metal oxides, and rare earth metal oxides; and

20

(v) from about 0.025g/in^3 to about 0.5g/in^3 of a first zirconium component; and

(b) in the second layer;

(i) from about 0.15g/in^3 to about 2.0g/in^3 of the second support;

(ii) from about 0.3g/in^3 to about 1.8g/in^3 of the SO_x sorbent

25

component;

(iii) at least about 1g/ft^3 of a second platinum group component;

(iv) at least about 1g/ft^3 of a second platinum group metal component other than platinum; and

30

(v) from about 0.025g/in^3 to about 0.5g/in^3 of a second zirconium component.

49. The axial layered catalyst composite as recited in claim 34, wherein

(1) the first layer on the downstream substrate further comprises a NO_x sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(2) the second layer on the upstream substrate comprises a SO_x sorbent component which is MgAl_2O_4 ; and further comprising a first midstream section located between the upstream section and the downstream section:

(3) the first midstream section comprising:

(a) a first midstream substrate; and

(b) a third layer on the first midstream substrate, the third layer comprising:

(i) a third support; and

(ii) a third SO_x sorbent component which is selected from the group consisting of BaO and MgO .

50. The axial layered catalyst composite as recited in claim 49, wherein the third SO_x sorbent component in the third layer is BaO .

51. The axial layered catalyst composite as recited in claim 49, wherein the third SO_x sorbent component in the third layer is MgO .

52. The axial layered catalyst composite as recited in claim 49, wherein the NO_x sorbent component in the first layer is a composite of $\text{Cs}_2\text{O}/\text{K}_2\text{O}/\text{CeO}_2$.

53. The axial layered catalyst composite as recited in claim 49, wherein the third layer further comprises a third platinum group metal component.

54. The axial layered catalyst composite as recited in claim 53, wherein the third layer further comprises a third platinum group metal component other than platinum.

5 55. The axial layered catalyst composite as recited in claim 49, wherein the third layer further comprises a zirconium component.

56. The axial layered catalyst composite as recited in claim 49, wherein

10 (1) the third layer on the first midstream substrate comprises a third SO_x sorbent component which is MgO ; and further comprising a second midstream section located between the downstream section and the first midstream section:

(2) the second midstream section comprising:

15 (a) a second midstream substrate; and

(b) a fourth layer on the second midstream substrate, the fourth layer comprising:

(i) a fourth support;

(ii) a fourth SO_x sorbent which is BaO .

20

57. The axial layered catalyst composite as recited in claim 56, wherein the fourth layer further comprises a fourth platinum group metal component.

25 58. The axial layered catalyst composite as recited in claim 57, wherein the fourth layer further comprises a fourth platinum group metal component other than platinum.

59. The axial layered catalyst composite as recited in claim 56,
30 wherein the fourth layer further comprises a zirconium component.

60. A radial layered catalyst composite comprising a bottom layer, a first middle layer, and a top layer:

(a) the bottom layer comprising:

(i) a first support;

5 (ii) a first platinum component;

(iii) a first NO_x sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(b) the first middle layer comprising:

(i) a second support;

10 (ii) a second SO_x sorbent component which is selected from the group consisting of BaO and MgO; and

(c) the top layer comprising:

(i) a third support;

15 (ii) a third SO_x sorbent component which is MgAl_2O_4 .

61. The radial layered catalyst composite as recited in claim 60, wherein the first NO_x sorbent component in the bottom layer is a composite of $\text{Cs}_2\text{O}/\text{K}_2\text{O}/\text{CeO}_2$.

20 62. The radial layered catalyst composite as recited in claim 60, wherein the second SO_x sorbent component in the first middle layer is BaO.

63. The radial layered catalyst composite as recited in claim 60, wherein the second SO_x sorbent component in the first middle layer is MgO.

25

64. The radial layered catalyst composite as recited in claim 60, wherein the first middle layer further comprises a second platinum group metal component.

30 65. The radial layered catalyst composite as recited in claim 60, wherein the top layer further comprises a third platinum group metal component.

66. The radial layered catalyst composite as recited in claim 60, wherein the bottom layer further comprises a first platinum group metal component other than platinum.

5

67. The radial layered catalyst composite as recited in claim 64, wherein the first middle layer further comprises a second platinum group metal component other than platinum.

10

68. The radial layered catalyst composite as recited in claim 65, wherein the top layer further comprises a third platinum group metal component other than platinum.

15

69. The radial layered catalyst composite as recited in claim 60, wherein at least one of the bottom, first middle, or top layers further comprises a zirconium component.

20

70. The radial layered catalyst composite as recited in claim 60, wherein the first middle layer (b) comprises a SO_x sorbent component which is MgO; and further comprising a second middle layer located between the bottom layer and the first middle layer:

(d) the second middle layer comprising:

(i) a fourth support; and

25

(ii) a SO_x sorbent component which is BaO or MgO.

30

71. The radial layered catalyst composite as recited in claim 70, wherein the second middle layer further comprises a fourth platinum group metal component.

72. The radial layered catalyst composite as recited in claim 71, wherein the second middle layer further comprises a fourth platinum group metal component other than platinum.

5 73. The radial layered catalyst composite as recited in claim 70, wherein the second middle layer further comprises a zirconium component.

74. A method for removing NO_x and SO_x contaminants from a gaseous stream comprising the steps of:

10 (A) in a sorbing period, passing a lean gaseous stream within a sorbing temperature range through a layered catalyst composite comprising a first layer and a second layer:

 (a) the first layer comprising a first support and a first platinum component; and

15 (b) the second layer comprising a second support and a SO_x sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.;

to sorb at least some of the SO_x contaminants into the second layer and thereby provide a SO_x depleted gaseous stream exiting the second layer and entering the first
20 layer, wherein the first layer sorbs and abates the NO_x in the gaseous stream; and

 (B) in a desorbing period, converting the lean oxidative stream to a rich reductive gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO_x contaminants from the second layer and thereby provide a SO_x enriched gaseous
25 stream exiting the second layer.

75. The method as recited in claim 74, wherein the first and second supports are the same or different and are compounds selected from the group consisting of silica, alumina, and titania compounds.

76. The method as recited in claim 74, wherein the first and second supports are the same or different and are activated compounds selected from the group consisting of alumina, silica, silica-alumina, alumino-silicates, alumina-zirconia, alumina-chromia, and alumina-ceria.

5

77. The method as recited in claim 76, wherein the first and second supports are activated alumina.

78. The method as recited in claim 74, wherein the SO_x sorbent component has a free energy of formation from about 0 to about -60 Kcal/mole at 350°C.

79. The method as recited in claim 78, wherein the SO_x sorbent component has a free energy of formation from about -30 to about -55 Kcal/mole at 350°C.

80. The method as recited in claim 74, wherein the SO_x sorbent component is selected from the group consisting of oxides and aluminum oxides of lithium, magnesium, calcium, manganese, iron, cobalt, nickel, copper, zinc, and silver.

81. The method as recited in claim 80, wherein the SO_x sorbent component is selected from the group consisting of MgO, MgAl₂O₄, MnO, MnO₂, and Li₂O.

25

82. The method as recited in claim 81, wherein the SO_x sorbent component is MgO or Li₂O.

83. The method as recited in claim 74, wherein the first layer further comprises a first platinum group metal component other than platinum.

30

84. The method as recited in claim 83, wherein the first platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

5 85. The method as recited in claim 84, wherein the first platinum group metal component is palladium.

10 86. The method as recited in claim 74, wherein the second layer further comprises a second platinum group metal component.

15 87. The method as recited in claim 86, wherein the second platinum group metal component is selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium, and mixtures thereof.

20 88. The method as recited in claim 87, wherein the second platinum group metal component is platinum.

25 89. The method as recited in claim 86, wherein the second layer further comprises a second platinum group metal component other than platinum.

30 90. The method as recited in claim 89, wherein the second platinum group metal component is selected from the group consisting of palladium, rhodium, ruthenium, iridium, and mixtures thereof.

35 91. The method as recited in claim 74, wherein the first layer comprises at least about 1g/ft^3 of the first platinum component.

40 92. The method as recited in claim 86, wherein the second layer comprises at least about 1g/ft^3 of the second platinum group component.

93. The method as recited in claim 74, wherein the second layer comprises from about 0.03g/in³ to about 2.4g/in³ of the SO_x sorbent component.

94. The method as recited in claim 93, wherein the second layer
5 comprises from about 0.3g/in³ to about 1.8g/in³ of the SO_x sorbent component.

95. The method as recited in claim 74, wherein the first layer further comprises a NO_x sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components.

10

96. The method as recited in claim 95, wherein the NO_x sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium, oxides of potassium, sodium, lithium, and cesium, and oxides of cerium, lanthanum, praseodymium, and neodymium.

15

97. The method as recited in claim 96, wherein the NO_x sorbent component is selected from the group consisting of oxides of calcium, strontium, and barium.

20

98. The method as recited in claim 96, wherein the NO_x sorbent component is selected from the group consisting of oxides of potassium, sodium, lithium, and cesium.

25

99. The method as recited in claim 96, wherein the NO_x sorbent component is selected from the group consisting of oxides of cerium, lanthanum, praseodymium, and neodymium.

30

100. The method as recited in claim 96, wherein the NO_x sorbent component is at least one alkaline earth metal component and at least one rare earth metal component selected from the group consisting of lanthanum and neodymium.

101. The method as recited in claim 74, wherein at least one of the first or second layers further comprises a zirconium component.

102. A method for removing NO_x and SO_x contaminants from a gaseous stream comprising the steps of:

(A) in a sorbing period, passing a lean gaseous stream within a sorbing temperature range through an axial layered catalyst composite comprising an upstream section and a downstream section:

(1) the downstream section comprising:

- (a) a downstream substrate; and
- (b) a first layer on the downstream substrate, the first layer comprising a first support and a first platinum component;

(2) the upstream section comprising:

- (a) an upstream substrate; and
- (b) a second layer on the upstream substrate, the second layer comprising a second support and a SO_x sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at $350^\circ\text{C}.$; to sorb at least some of the SO_x contaminants into the upstream section and thereby provide a SO_x depleted gaseous stream exiting the upstream section and entering the downstream section, wherein the downstream section sorbs and abates the NO_x in the gaseous stream; and

(B) in a desorbing period, converting the lean oxidative gaseous stream to a rich reductive gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO_x contaminants from the upstream section and thereby provide a SO_x enriched gaseous stream exiting the upstream section.

103. The method as recited in claim 102, wherein

- (1) the first layer on the downstream substrate further comprises a NO_x sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(2) the second layer on the upstream substrate comprises a SO_x sorbent component which is MgAl_2O_4 ; and further comprising a first midstream section located between the upstream section and the downstream section:

5 (3) the first midstream section comprising:

(a) a first midstream substrate; and

(b) a third layer on the first midstream substrate, the third layer comprising:

(i) a third support; and

10 (ii) a third SO_x sorbent component which is selected from the group consisting of BaO and MgO ;

to sorb at least some of the SO_x contaminants into the first midstream section and thereby provide a SO_x depleted gaseous stream exiting the first midstream section and entering the downstream section, wherein the downstream section sorbs and
15 abates the NO_x in the gaseous stream; and

(B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO_x contaminants from the first midstream section and thereby provide a SO_x enriched
20 gaseous stream exiting the first midstream section.

104. A method for removing NO_x and SO_x contaminants from a gaseous stream comprising the steps of:

(A) in a sorbing period, passing a lean gaseous stream within a sorbing
25 temperature range through a radial layered catalyst composite comprising a bottom layer, a first middle layer, and a top layer:

(a) the bottom layer comprising:

(i) a first support;

(ii) a first platinum component;

30 (iii) a first NO_x sorbent component selected from the group consisting of cesium components, potassium components, and cerium components; and

(b) the first middle layer comprising:

(i) a second support;

(ii) a second SO_x sorbent component which is selected from the group consisting of BaO and MgO; and

5 (c) the top layer comprising:

(i) a third support;

(ii) a third SO_x sorbent component which is MgAl_2O_4 ;

to sorb at least some of the SO_x contaminants into the top and first middle layers and thereby provide a SO_x depleted gaseous stream exiting the top and first middle
10 layers and entering the bottom layer, wherein the bottom layer sorbs and abates the NO_x in the gaseous stream; and

(B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a desorbing temperature range to thereby reduce and desorb at least some of the SO_x
15 contaminants from the top and first middle layers and thereby provide a SO_x enriched gaseous stream exiting the top and first middle layers.

105. The method as recited in claim 104, wherein

(3) the first middle layer comprises a SO_x sorbent component which is MgO;

20 and

further comprising a second middle layer located between the bottom layer and the first middle layer:

(d) the second middle layer comprising:

(i) a fourth support; and

25 (ii) a SO_x sorbent component which is BaO;

to sorb at least some of the SO_x contaminants into the second middle layer and thereby provide a SO_x depleted gaseous stream exiting the second middle layer and entering the bottom layer, wherein the bottom layer sorbs and abates the NO_x in the gaseous stream; and

30 (B) in a desorbing period, converting the lean gaseous stream to a rich gaseous stream and raising the temperature of the gaseous stream to within a

desorbing temperature range to thereby reduce and desorb at least some of the SO_x contaminants from the second middle layer and thereby provide a SO_x enriched gaseous stream exiting the second layer.

5 106. A method of forming a layered catalyst composite which comprises the steps of:

(a) forming a first layer comprising:

(i) a first support; and

(ii) a first platinum component; and

10 (b) coating the first layer with a second layer comprising:

(i) a second support; and

(ii) a SO_x sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at 350°C.

15 107. The method as recited in claim 106, wherein the first layer further comprises a first platinum group metal component other than a platinum component, a NO_x sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components, and a first zirconium component.

20 108. The method as recited in claim 106, wherein the second layer further comprises a second platinum component, a second platinum group metal component other than platinum, and a second zirconium component.

25 109. A method of forming a layered catalyst composite which comprises the steps of:

(a) combining a water-soluble or dispersible first platinum component and a finely divided, high surface area refractory oxide with an aqueous liquid to form a first solution or dispersion which is sufficiently dry to absorb essentially all
30 of the liquid;

(b) forming a first layer of the first solution or dispersion on a substrate;

(c) converting the first platinum component in the resulting first layer to a water-insoluble form;

5 (d) combining a water-soluble or dispersible SO_x sorbent component having a free energy of formation from about 0 to about -90 Kcal/mole at $350^\circ\text{C}.$, and a finely divided, high surface area refractory oxide with an aqueous liquid to form a second solution or dispersion which is sufficiently dry to absorb essentially all of the liquid;

10 (e) forming a second layer of the second solution or dispersion on the first layer; and

(f) converting the second platinum component in the resulting second layer to a water-insoluble form.

15 110. The method as recited in claim 109, wherein the first solution or dispersion further comprises a first platinum group metal component other than a platinum component, a NO_x sorbent component selected from the group consisting of alkaline earth metal components, alkali metal components, and rare earth metal components, and a first zirconium component.

20 111. The method as recited in claim 109, wherein the second solution or dispersion further comprises a second platinum component, a second platinum group metal component other than platinum, and a second zirconium component.

25 112. The method as recited in claim 109, wherein the step of converting the first platinum component comprises calcining the first layer.

30 113. The method as recited in claim 111, wherein the step of converting the second platinum component and second platinum group metal component other than platinum comprises calcining the second layer.

114. The method as recited in claim 111, further comprising the steps of:

(i) comminuting the water-insoluble, first platinum component in a first coat slurry, forming a first layer of the first slurry, and drying the first slurry;

5 and

(ii) comminuting the water-insoluble, second platinum components in a second coat slurry, forming a second layer of the second slurry on the first layer, and drying the second slurry.

10 115. The method as recited claim 114, wherein the comminuting provides a slurry in which most of the solids have particle sizes of less than about 10 microns.

15 116. The method as recited claim 115, wherein at least one of the first and second slurries contains acetic acid or nitric acid.

117. The method as recited in claim 114, wherein the first platinum component and second platinum components are platinum nitrate.

20 118. The method as recited in claim 109, further comprising the step of forming the first layer on a honeycomb substrate.